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THE DEPARTMENT OF DEFENSE STATEMENT ON THE SCIENCE AND TECHNOLOGY PROGRAM

by

MR. H. MARK GROVE
ASSISTANT DEPUTY UNDER SECRETARY
OF DEFENSE
FOR
RESEARCH AND ADVANCED TECHNOLOGY

BEFORE THE
DEFENSE SUBCOMMITTEE
OF THE
COMMITTEE ON APPROPRIATIONS
OF THE
UNITED STATES HOUSE OF REPRESENTATIVES
97th CONGRESS, SECOND SESSION

16 JUNE 1982

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The FY 1983 Department of Defense
Program for Science and Technology
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Mr. Chairman and Members of the Committee

I. INTRODUCTION

I am grateful for the opportunity to testify in support of the Department of Defense FY 1983 Science and Technology (S&T) Program. This hearing is the first time I have had the pleasure of addressing this committee, and I would like to begin by briefly reviewing the changes the present Administration has already made and the emphasis I intend to place in managing the program.

As you know, the Secretary of Defense and Under Secretary of Defense for Research and Engineering have proposed an Assistant Secretary of Defense for Research and Technology who will also serve as Director, Defense Advanced Research Projects Agency. We will be working very closely with the new Assistant Secretary to provide a better basis for R&D planning, improved coordination between the Services and Defense Agencies and earlier insertion of successful technology demonstrations into new systems.

Today, I would like to describe to you our objectives for the DoD S&T Program, how we view the threat represented by the very large Soviet RDT&E effort, how we plan to capitalize on the strength of our system -- our free industry, universities, allies and the openness of our society -- to offset the Soviet numerical and budgetary advantages, and how we intend to incorporate the results of various studies of the Technology Base into a more efficient and effective program.

Our goals and objectives are to use our superior technology to offset Soviet numerical superiority, to keep ahead of the growing Soviet technical capability, to maintain the capability of our military systems, to reduce costs, to improve the productivity in our industrial base, and to enhance the return on the country's investment in defense systems.

To achieve these objectives we are utilizing all three of our major resources. More than half of the S&T Program is executed by U.S. industry; about one-sixth by universities; and about one-third by the DoD in-house laboratories. Over half of our basic research program is executed by the universities and I want to return later to a special study concerning their ability to support our efforts and our plans for enhancing that capability. I also want to discuss the results of a special study on the DoD laboratories and the resulting recommendations for strengthening that very important resource.

The responsibility assigned is large, but not overwhelming. The challenges we face are exciting but not excessive. Our resources are strained, but with the support of the Congress which we have enjoyed in the past, I am confident that we can continue to rely on our scientists and engineers and the advantages of our free and open society to offset the formidable threat we face.

The DoD Science and Technology Program includes Research (6.1), Exploratory Development (6.2) and Advanced Technology Developments (6.3A) of the three Military Departments and the Defense Agencies (Defense Advanced Research Projects Agency, Defense Nuclear Agency, and the Uniformed Services University of the Health Sciences). Our request for FY 1983 is $4.3 billion or approximately two percent of the total DoD budget. The details are outlined in Table 1.

II. POLICIES

The entire U.S. military structure is based upon exploiting technological superiority. Even if we wished to adopt a different strategy, it is very likely that we no longer have the option to change. The Soviet Union and the Warsaw Pact nations outnumber us and our NATO allies in terms of manpower and equipment of war to such a great extent that we cannot match them tank for tank or missile for missile without increasing our military forces beyond numbers our economy can support, short of mobilization. Thus a strong, viable and productive S&T Program is essential to our military security.

We continue to have the overall objective in the DoD S&T Program to maintain a level of technological supremacy which enables the United States to develop, acquire and maintain military capabilities needed for our national security. To this end we are seeking continued real growth in the program.

In the future we intend to look at long-term technology needs based on scenarios which envision that future conflicts will take place under very fluid battlefield conditions. This assumption postulates that improved weapons (tanks, aircraft, ships, etc.) will not be basically different from those of today but that major concentrations of troops and equipment may not be practical. Therefore, new tradeoffs among mobility, agility and firepower become essential. Small unit actions, finding the enemy, integrating C^3I/nuclear/chemical/electronic warfare, and dispersed forces become the battlefield problems of the future. Among the specific technologies that become important are those that will permit us to conduct sustained operations, to locate and track hostile forces continuously, to provide real-time information management, to counter hostile acquisition systems, to provide capabilities "transparent" to technical complexity, to ensure high equipment availability as well as reliability and to provide those equipments that can operate in extreme environments. In evaluating the opportunity-to-technology risk ratio as a criterion, we have identified a group of technologies that could, in our view, "make a difference."

We will be continuing our emphasis on current thrusts in directed energy and directed energy countermeasures, very high speed integrated circuits (VHSIC), the Ada language program, adverse weather precision guided munitions, advanced materials and chemical warfare. However, we believe that stronger effort is required in selecting additional technologies for management and funding emphasis. Among the disciplines we plan to review and consider for future emphasis are:

- Microelectronics (with emphasis on VHSIC), fail safe/fault tolerant electronics, and hardening against all types of radiation;
- Advanced software techniques including their development and support environments; machine intelligence, supercomputers, optical processing and communications; and microprocessor-based personal learning aids;
- Rapid solidification technology, advanced composite materials; and large space structures;
- Active and passive stealth for aircraft and structures; space nuclear power; space based radar; infrared arrays; high power microwaves; and short wavelength lasers.

To speed the introduction of these evolutionary technological opportunities into our military systems, we will apply the concept of Pre-Planned Product Improvement (P^3I). By this procedure we will insert advanced technology, which has been demonstrated as mature, into deployed systems through upgrades of those subsystems that offer the greatest overall benefits. The payoff is a reduced lead time to fielding technological advances while obtaining significant improvements in military capability over the service life of the system.

We are taking steps to improve coordination and planning of cross-Service technologies, reduce unnecessary redundancy, and to exploit more fully and rapidly the most promising developments. The erosion of our technology base is a national problem and we will continue to work the broader problem to ensure that the U.S. maintains a technological edge.

Last summer the Defense Science Board reviewed the Technology Base. In general, the report was supportive of our ongoing efforts. They suggested that the Services adopt "scenarios" to focus their technology efforts, and the following "catechism" to develop a well-founded investment strategy:

- What is it? What is this effort trying to accomplish (defining the technology sufficiently well to discriminate it from other similar technologies)?

- Why is it important? Assuming success, what difference can it make to the user or in a mission area context (taking into account the nature and limitation of current practice)?

- What is the current status? What is the DoD program? What should it be? What is new about the proposed effort and why will this approach be successful?

- How long will it take? How much will it cost? What are the measures of success?

Although these are fundamental questions, we feel that more attention to frank answers and to how the intervening efforts fit together is what oversight responsibility is all about.

The DSB study also was critical of the barriers to successful transition of technology into operational systems. The principal barriers were identified as:

- o Partitioning the research, development, and production process into separate organizations and contractors
- o Lack of involvement of potential users in the establishment of requirements and the resulting programs
- o Lack of fenced budgets to allow the product activities to fund transition of desired technologies
- o The failure to meet an "opportunity window"
- o The lack of a risk/reward system
- o Existence of mature hardware options

A strong recommendation was to require technology insertion plans as a basic and fundamental part of program planning. To a certain extent, our P^3I initiative will help satisfy this need, but we are also exploring other, more effective ways to improve the transition process.

The DSB performed two reviews of the contribution the universities can make to the DoD technology base. They found that the universities and DoD need each other. DoD needs the scientists and engineers trained by the universities; it needs the faculty pool of scientists and engineers working in the DoD area as originators of new ideas and as expert consultants and advisers. The university research base for defense preparedness is in considerable disrepair and therefore in need of upgrading in faculty, equipment, facilities and support. The problem is much broader than DoD, but DoD has a specific interest and responsibility and a critical need to see that a solution is found and that the salution is enduring.

Mechanisms are needed to stimulate both quality and quantity in the training of scientists and engineers in defense-related subjects, especially in the more advanced technologies, to encourage their employment in the universities and DoD procurement process.

We have responded to these findings by:

- o Increasing the amount of research to be performed by the universities
- o Increasing science and engineering fellowships
- o Increasing funding to upgrade research equipment in universities

We have also instituted other initiatives to improve the responsiveness of the universities. We are seeking ways to encourage much closer cooperation between the industry and the universities through the industry's independent research and development (IR&D) program. In this way we hope not only to strengthen the universities, but also shorten the time required to get new technology out of the labs and into our systems.

The DSB also examined the in-house laboratory posture. To build on their review, and that of our own in-house Laboratory Management Task Force, Dr. DeLauer asked Dr. Robert Hermann, formerly an Assistant Secretary of the Air Force, to conduct an indepth review of the DoD Laboratories. Dr. Hermann submitted his report in March, and we will take on his group's findings and recommendations as a point of departure to restore the vitality and viability of the laboratories, which represent a most important resource: 60,000 workers, almost 30,000 of whom are scientists and engineers, plus physical resources worth in excess of $4 billion.

The study team found:

- There is indeed a strong and continuing need for the DoD to maintain the laboratories and R&D centers.

- Much good work is being done in the laboratories and technology created by the laboratories continues to make its way into the operating forces.

- There exists a disconnect between the laboratories and the operating forces which exacerbates the problem of technology transition to the field.

- Industry, the laboratories, and the user community all feel cheated by the existing process.

- The time is ripe for improving the DoD/University R&D connection.

- There are new technology opportunities and technology base operational functions which have evolved in recent years that require special DoD attention to realize the maximum benefit.

- The technology environment surrounding the laboratories has dramatically changed in recent years, which requires that DoD and the Services reassess the laboratories' roles and missions.

We are now planning our course of action. We plan to use the Laboratory Management Task Force to implement most of our actions. Most importantly, with the support of the Congress, we have already achieved two important objectives: relief on the Determination and Findings ceiling and relief on the high grade personnel ratio. We are now attempting to evaluate the nature and severity of our manpower problems, and we are working closely with the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics to determine what can and should be done to revise and strengthen our laboratory personnel practices. We may have proposed legislation this fall.

Some of the more interesting recommendations of the Hermann Group are:

- o Establish an external advisory group for each laboratory
- o Establish an outside (of DoD) expert review process which would assess each laboratory's effectiveness every 3 to 5 years.
- o Couple laboratories to operational forces more effectively by assigning laboratory personnel to unified and specified Commands.
- o Establish a formal "logistics R&D program"

By next year we plan to present to you the specific actions necessary to protect and improve the DoD laboratories.

In the last year, we have also become more deeply concerned over the future supply of scientists and engineers. We rely on the universities almost exclusively for trained scientists and engineers at the bachelor and graduate levels. Although there are more students enrolled in engineering colleges than at any time in our history, the enrollment in graduate schools is down significantly, especially for U.S. students. In some universities and for some disciplines, almost half the graduate students are foreign nationals. In addition, there already exists a significant shortage in engineering faculty. Nationally, approximately ten percent of all engineering faculty positions are vacant with 200 vacancies in computer sciences alone. Taken together, these facts forecast an alarming lack of American engineers as faculty candidates in the future, threatening a serious change in the educational procedures for our future engineers. This problem is a critical one which feeds upon itself and about which we as a nation must take clear and decisive action. We now have several actions underway to address the need to increase the number of U.S. graduate students in engineering:

- The Army, Navy and Air Force have all initiated fellowship programs and by FY 83 will be supporting more than 100 fellows in defense related disciplines. The Air Force fellowship program focuses on thermionic engineering, advanced composite structures and research in aircraft technology; the Army currently plans emphasis on computer sciences, vertical lift technology and advanced materials. The Navy will target its fellowship support to students in electrical engineering, computer sciences, naval architecture, applied physics, materials sciences and mechanical and aerospace engineering, and is implementing this program with the help of the American Society for Engineering Education.

- Our basic research program also indirectly supports many graduate students. For example, a Navy study conducted in FY 1980 shows that the Office of Naval Research supports an estimated 2,000 graduate students (some partially) through its contract research programs. The number for all three services is probably close to 4,000 graduate students.

- The summer faculty program at our DoD labs provided summer research opportunities to more than 200 faculty members last year.

Below the baccalaureate level, we have initiated a science and engineering apprenticeship program for high school students. To date, several hundred promising high school students have worked in DoD laboratories or with university researchers under contract to DoD. The program provides students with exposure to research techniques under the guidance of a senior mentor and alerts these youngsters to the need to take the right math and science courses while still in high school in preparation for technical careers. Other actions that help improve the engineering problems are:

- A new section of the recently passed Defense Authorization Act of 1982 will enable our R&D laboratories to contract with educational and non-profit institutions for the research services of college and university students. Regulations to implement this program are currently being developed.

- The Navy and the Air Force have stipulated that certain percentages of their ROTC scholarships must go to students enrolled in science or engineering fields of study. The Navy requires 80%, and the Air Force, 70%, of all scholarships to focus on these areas.

- The Defense Communications Acency, in conjunction with the Armed Forces Communications and Electronics and Electronics Association, has developed a joint project titled the Partnership for the Development of National Engineering Resources. Designed to stimulate interest in science, engineering and technology among high school and college students, the Partnership seeks industry sponsorship of a number of efforts such as plant tours, work-study programs, scholarships, equipment donations and other activities that can expose young people to potential careers in science, engineering and technology.

III. SELECTED MAJOR FY 1983 TECHNICAL PROGRAMS

I will focus here on some of the technical programs in the S&T program which are of particular significance and illustrate the importance of the FY 1983 planned efforts.

A. Research

There is no doubt that the technological superiority upon which we depend for our security is being challenged as never before by our potential adversaries. And it is equally clear that our ability to meet this challenge will depend in large measure upon the maintenance of an imaginative, broadly-based program of basic research to provide a continuing flow of new concepts and technological options for the solution of current and future national defense problems.

Before proceeding to a description of the research directions to be emphasized in FY 1983, it is appropriate to note some of the accomplishments of the past year. The following examples are particularly noteworthy:

- New Armor Penetrator Technology for Anti-Tank Warfare. Far more lethal armor penetrator warheads for use against tanks and other armored vehicles will result from a new theoretical shaped-charge model for designing anti-armor munitions.

- Improved Safety and Mission Effectiveness of Helicopters. A new nondestructive test method will locate previously undetectable helicopter rotor blade flaws which could, if undetected, lead to catastrophic failure.

- Low Cost Missile Seekers. Research in computer technology has led to a very small and inexpensive missile seeker which can autonomously acquire a target, track it, and provide guidance signals.

- New Submarine Detection Technology. Advances in optical sciences and electronics have led to development of a new kind of hydrophone based on optical fibers. The new hydrophone detector operates at low frequency with very low noise levels and very high sensitivity.

The Research Program in FY 83 will continue to cover a broad range of science and engineering topics which are of critical importance to the defense mission. The funding increase in FY 83 will be used to strengthen areas where additional support is urgently needed to overcome serious inadequacies in the current level of effort. These include the following:

- Free Electron Laser (FEL). The FEL, which was first demonstrated at Stanford University in 1977 under an Air Force contract, has the potential for efficiently producing high-power, coherent radiation which in principle can be tuned from the millimeter to the x-ray region of the spectrum. It has already demonstrated a megawatt of pulsed power at 400 micrometer wavelength, and further progress is expected.

- Sub-Microelectronics for Millimeter Generation. It is vital to understand the fundamental limitations of the operating ranges of electronic devices, both semiconductor and tube type. The extension of limiting parameters (such as frequency response, speed, power, sensitivity, dynamic range, and the like) is of immediate interest. Some exceptionally critical programs fall within this area, such as the entire field of near-millimeter wave (100 to 1000 GHz) sources and detectors, of which there is currently a severe lack, especially in the atmospheric transmission windows at 140 and 230 GHz. An important aspect of the electronics program is a new tri-Service 6.1 program on Ultra-small Electronics Research (USER).

  The advent of high-resolution electronic, x-ray, molecular, and ion beam lithographic techniques is pushing toward an era of ultra-small devices in which individual feature sizes might well be fabricated on the molecular scale, the goal being 0.02 micrometer resolution.

- Computers and Information Processing. Topics of particular interest in information processing include computer architectures for efficient distributed processing, controls to improve memory-access techniques, reliable digital transmissions, software cost reduction, tecnhiques for more reliable software, Ada based programming environments, simplified operating systems, and improved methods for parallel processing, and artifical intelligence. An important effort has been established in artificial intelligence and robotics directed at developing "smart" computer systems with capabilities for common sense reasoning and physical dexterity normally attributed to humans. It includes fundamental research on machine representation of knowledge, language and speech understanding, computer vision, machine controlled manipulators, and reasoning by analogy and inference. Directly tied to the artifical intelligence project are efforts in robotics and industrial automation.

We intend to maintain the real growth of the research effort started last year, and have requested an increase in real terms from FY 82 to FY 83 of about eight percent. The importance of strengthening the research effort becomes apparent when we recognize that today's vital military capabilities, for example the evolving cruise missiles, stealth aircraft, and powerful new antitank weaponry, are derived from basic research done 10 to 20 years ago. The other side of the ledger also displays compelling evidence of the need for increased research, as shown by the Soviet superiority in new types of submarines, satellite killers and enhanced chemical warfare capabilities.

Management of the Research Program is the subject of continuing examination, and every effort is made to ensure the effectiveness of our investment. A management initiative which encouraged multi-disciplinary (cluster) programs as a means of addressing complex DoD problem areas has been substantially expanded to over 600 clusters, with 200 of these in universities. In addition, a special kind of cluster program, designated as Selected Research Opportnities, has been established by ONR to emphasize interaction between DoD sponsored university programs and related efforts in industrial and in-house laboratories. The Air Force has undertaken a similar approach through its Multi-Investigator Program.

Another management initiative we have recently undertaken addresses the growing shortage of scientists and engineers in fields critical to defense. We are concerned with the increasing difficulty of inducing able students to pursue graduate training and research in fields where the demand for specialists is greatest. The universities play a key role, yet graduate student enrollment in engineering has declined; only about one-half of the new Ph.D's in engineering received their first degree in the United States. The whole question of DoD-university relationships is of intense interest to both DoD and academia, and has been given high priority within DoD. A Defense Science Board Task Force has prepared a report for Congress on university responsiveness to DoD needs. Joint meetings of DoD personnel are frequently held with university representatives, professional societies, the National Science Foundation, industry groups, and others. Programmatic actions include a $30 million per year initiative starting in FY 83 to update and replace obsolete university instrumentation used in the pursuit of research for DoD. Starting in FY 83 the DoD will offer graduate fellowships in selected technologies of interest to the Department. We have a high school apprenticeship program to introduce high school students to technology by working in DoD laboratories. There is a program to bring university faculty to work in DoD laboratories and to consult on both technical and policy issues. An informal DoD/University Forum is now being set up to facilitate the exchange of views on a regular periodic basis between senior DoD and university people.

B. Directed Energy

The DoD Directed Energy Program, with elements in each of the Services and DARPA, continues to explore the feasibility of using high energy laser and particle beam technology in a variety of military mission applications, ranging from forward area combat weapons on the Army battlefield to strategic missions. Recent accomplishments include:

- Award of the military construction contract for the DoD High Energy Laser Systems Test Facility (HELSTF) at the White Sands Missile Range (WSMR), New Mexico. Construction was approximately 63% complete as of 31 December 1981.

- Continued operation and characterization of the Navy's Mid Infrared Advanced Chemical Laser (MIRACL), which demonstrated lasing performance with good beam quality in February 1981. Fabrication of the beam director and other equipment continues.

  These subsystems will be installed and integrated into a complete system WSMR for the conduct of the Navy's Sea Lite lethality demonstrations.

- The Army has embarked upon two new demonstrator programs, one for a forward area laser weapon and a second for a close combat laser weapon for use in the Army's forward area battlefield. The former has entered a competitive design phase and a contract for the latter was awarded in April 1982.

- Initial in-flight testing of the Airborne Laser Laboratory with the high power laser in operation and the beam directed against a target occurred in FY 1981. While system lethality against this target was not conclusively demonstrated, significant advances were made in target acquistion and tracking, and also in pointing a high power laser beam at a target under realistic airborne engagement conditions. Testing continues in fiscal year 1982. Initial facility activation and testing of the annular gain generator for the cylindrical chemical laser occurred in April 1981.

- The report to Congress on Space Laser Weapons was prepared and submitted in May 1981, with a recommendation that the program be augmented by $50 million per year. A detailed program plan is presently in development leading to a decision in the latter part of this decade on whether to proceed with an on-orbit demonstration prototype.

FY 1983 Service plans for the directed energy program include:

- Completion of construction of the High Energy Laser Systems Test Facility, and beginning of the movement and installation of the laser, beam director, and other equipment at White Sands Missile Range. This equipment will be assembled into a complete high energy laser lethality demonstrated system for generic surface based air defense with emphasis on anti-ship missile defense.

While principally a Navy program, there will be significant Army and Air Force participation.

- Following completion of the preliminary design competition, the Army plans to select one contractor for a detailed design and fabrication of the Forward Area Laser Demonstrator (FALW-D). Fabrication of the Roadrunner demonstrator of a Close Combat Laser Weapon (CCLAW) will continue.

- Air Force plans include continued work on a new fire control system which will permit multiple missile engagements by the Airborne Laser Laboratory, and on the annular resonator and the annular gain generator to demonstrate a deuterium fluoride cylindrical chemical laser.

- Air Force efforts in space-based laser weapon technology will continue to address system issues in surveillance and warning, command and control, launch vehicle requirements, and overall integration and operation of a complete space-based laser weapon system.

The report to Congress on Space Laser Weapons concluded that space-based laser weapons could offer significant military potential provided that they were survivable to enemy attack. However, there are areas of major uncertainty in our ability to predict with confidence the ultimate utility of space-based laser weapons. Substantial improvement in the state-of-the-art of many areas of technology is required. Depending upon the particular mission requirements, the earliest availability of space-based laser weapons could be fifteen years or more.

A decision on whether to commit to a system development, including an on-orbit feasibility demonstration, should not be made until the uncertainties in technology and ultimate utility are resolved. We will pursue an aggressive research program to reduce these uncertainties.

C. Very High Speed Integrated Circuits (VHSIC)

The objective of the VHSIC Program is to provide dramatic improvement in our capability for high speed, high throughput signal and data processing of the type desired for military systems in the mid-1980s and beyond. This program seeks to accelerate the development of new technology for integrated circuits (IC) and to closely tie the resultant products to high priority military systems requirements.

The program promises to impact virtually every electronic system by providing a capability for up to a 100 times increase in signal processing speed and throughput with increased reliability and at lower system cost. In particular, advances have been identified for real time high resolution synthetic aperture radar, anti-jam communications, acoustic detection of submarines, image processing for fire and forget missile targeting, and onboard general purpose computers.

Initial VHSIC contract award decisions were made in February 1980. The program will extend through FY 1986. The current average annual funding rate is about $50 million. The most recent funding projection for the total program is $314 million. The program is a fully coordinated effort, executed through the Military Departments with overall management direction from my office. The program will be carried out principally through industrial and university contracts. The program is structured to encourage innovation from the private sector.

To meet its goals, the program was divided into three consecutive phases (Phase 0, I, and II) and an additional effort termed supporting technology, which will run concurrent with the consecutive phases. Phase 0 which was completed in March 1981 was a concept definition effort. It included system and subsystem analysis, partitioning studies, optimal approaches to silicon chip design layout, computer aided device modeling and experimental fabrication, and testing of designs, layouts and processing techniques. It resulted in a definitive plan in the form of a proposal for Phase I by each of the nine contractors. Phase I is now underway with six contracts awarded for a total effort of $167 million. These cover all technologies of interest and will provide IC for the system needs of all three Services.

Phase I consists of two parts. Phase IA will result in the establishment of a pilot line production capability for VHSIC chips with 1.25 micrometer feature sizes. The components resulting from this effort will be incorporated into subsystem brassboards for systems identified by the three Military Departments. This technology insertion aspect is considered to be the key part of the program. Phase IB will consist of initial efforts to extend the state-of-the-art of IC fabrication, design, architecture, software and test (DAST) to submicrometer feature sizes and associated higher gate densities.

Phase II will be similarly divided into two parts. It is planned to be initiated in April 1984. Phase IIA will provide system demonstrations of silicon chips designed to 1.25 micrometer rules. Phase IIB will attempt to extend the state-of-the-art of IC fabrication to submicrometer feature sizes to obtain higher rate densities and higher signal speeds. The end goal is to establish a pilot production capability to fabricate IC's with 0.5 micrometer feature sizes. Successful completion of Phase II will provide a significant new capability for military systems and, through technological fallout, aid the semiconductor industry in meeting worldwide competition.

The technology support phase runs in parallel throughout the program with periodic requests for proposals in areas where technology needs appear critical. Approximately thirty percent of VHSIC funding will be applied to this part of the program. To date, over 50 contract awards have been made under this part of the VHSIC Program.

In response to the Report of the Joint Congressional Conference on the DoD Authorization Bill, a VHSIC program office has been established under my cognizance to provide overall management of the VHSIC Program. A management plan was structured to:

- Couple DARPA and DNA programs with VHSIC efforts.
- Foster coordination with the intelligence communities in order to track U.S. technology implementation as well as technology lead over potential adversaries.

In order to control the export of developed technology, the program, where appropriate, will be placed under the International Traffic in Arms Regulations (ITAR). My program office has generated export control guidance that addresses three basic elements for export control; namely, the VHSIC devices themselves, the manufacturing or process equipment to make them, and the technical data for their design, manufacture or use. In general, the application of the ITAR and of existing Export Administration Regulations will be used to control these elements as appropriate. We are continuing to review these procedures to ensure their overall effectiveness.

In order to encourage rapid diffusion of VHSIC technology throughout the U.S. semiconductor industry, second sourcing clauses are part of the Phase I contracts. Similar clauses will be part of Phase II. These will require contractors to enter into licensing arrangements for the parts of their VHSIC manufacturing system (including software) developed under this program.

The National Materials Advisory Board has completed a study that will determine the specific impact(s) of the VHSIC Program on the general U.S. industry resource base. It is believe that the semiconductor industry spends approximately 10 percent of its annual sales on R&D ($300 million), and since the VHSIC Program averages about 15 percent of this amount ($50 million), industry can redirect ongoing R&D efforts to focus on VHSIC program goals with minimal interference to commercial development.

D. Embedded Computer Software Technology

Computers are utilized in virtually all military systems and computer software is becoming a critical element of those systems. It is essential to carry out the functions of command and control, navigation, surveillance, target acquisition and missile guidance. It also provides the framework for signal and image processing required for automating target acquisition, identification, and fire control. There is concern in military and commercial quarters with the present status of software development, where productivity measured in lines of code per programmer per day has not improved significantly over the years. By contrast startling advances in hardware technology during the past decade have led to large cost reductions per unit computation. This situation highlights the relative primitiveness of software technology. Development of software is more often described as an art than a science. The struggle to mature this technology to a disciplined engineering science has been painfully slow.

Although it is widely understood that software is a critical component of our systems and that the state of the art of this technology is a weak link in our technology base, there is no simple formulation of the problem. Software development and management have traditionally been human intensive activities with many dimensions. In recent years we have addressed this problem with modest efforts such as high order language standardization and common instruction architectures. Two years ago we began planning a major thrust called the software technology initiative and are continuing our efforts to develop a coordinated and consolidated tri-Service technical and management plan to systematically address this important program area.

The creation of the common high order programming language Ada, has established a baseline for transfer of evolving software technology. We are preparing for the application of this technology by continuing not only the development of Ada compilers, but a set of related software support tools and standards to reap the potential benefits. This set of tools is known as the Ada Program Support Environment (APSE). The Ada Program is an important example of tri-Service cooperation. Direction of the Ada Program and APSE efforts has been consolidated under the recently chartered Ada Joint Program Office (AJPO). Starting in FY 82 the AJPO was funded as a single program element under the Air Force budget.

Just as the software challenge is multi-dimensional so must our R&D strategy be multi-faceted. It is our intent to pursue not only better automated tools for programmers, but also aids for the designers, development managers and maintenance personnel.

Our objective is to achieve higher quality software products and improvement in software productivity. The entire life cycle of software will be addressed. Software maintenance which includes the correction of latent errors and evolutionary upgrades has been estimated to be in the range of four to five times the initial development cost. The time and cost to correct one bad line of code which enters the operational phase undetected, is equivalent to that of writing on the order of 200 lines of code during initial development. We will pursue innovation in management techniques as well as in maintenance. Emphasis will be on automated methods and human engineering to make the programmer's environment "user friendly." The proposed program will includes adaptation of newly available low cost personal computers for use as intelligent terminals equipped with a library of software packages, better management methodology including estimation and measurement techniques.

E. Chemical Warfare

To meet the chemical warfare threat posed by the Soviet and Warsaw Pact forces, the DoD has initiated an aggressive research and development program which, combined with increased procurement, promises a greatly improved chemical warfare and defense posture in the near term.

The 1980 Defense Science Board recommendation to expand the science and technology base has been implemented. Substantial funding increases have been made, particularly in the area of research. There has been especially good university response in the area of medical prophylaxis and therapy. The other principal research emphasis is being placed on detection and warning, decontamination, and materials.

We have expanded the technology base program to develop new materials for protective garments and masks as well as to improve prophylaxis and therapy and develop an integrated doctrine for combat casualty care in a contaminated environment. Programs will continue in the areas of chemical, thermal, and radioactive decontamination as well as mechanical removal, charcoal regeneration and residual life monitors to increase useful life of filters and charcoal-bearing protection materials. New efforts on detection and alarm systems using potential techniques such as mass spectrometry, laser, microwave, ion mobility spectrometry and piezoelectric crystals will reduce the logistics burden and increase the sensitivity and specificity of detection.

In other development programs, remote sensing alarms, automatic liquid agent detectors, training simulators and devices, decontamination systems, and similified collective protection programs are in progress. Development will continue on vehicle hybrid collective protection systems, a lightweight decontamination system, and the jet exhaust decontamination system. All of these systems will reduce personnel incapacitation, and be a major factor in sustaining military operations on a contaminated battlefield.

F. Advanced Aircraft Technology

Our aircraft technology program continues to focus on those technologies which will:

- Reduce aircraft acquisition and support costs
- Develop new and more effective operational capabilities
- Increase vehicle survivability

We are also concerned with the problem of transferring advanced technology into new aircraft systems. The long lead times required to consider technology mature enough for application with acceptable risk (up to fifteen years in some cases) and the infrequent development of new aircraft systems, are major impediments to technology transition. In order to accelerate this transition, we are focusing on full scale flight demonstrations as they emerge, which will foster user/technologist interaction, insure technology maturity and lead to ultimate acceptence by the user. Secondly, we are developing technologies which can be applied to existing systems on a retrofit basis.

In our FY 1983 program, major areas which reflect the approach outlined above, include: (1) the Advanced Fighter Technology Intergration (AFTI) Program, (2) a nonmetallic composite helicopter fuselage, and (3) a new initiative to develop Short Take-Off and Landing (STOL) capability for fighter aircraft.

The Air Force AFTI program will provide significant improvements in fighter aircraft combat capability through the integration of advanced control concepts with mission avionics systems. The advanced concepts include the capability to independently control aircraft translational and rotational degrees of freedom, resulting in unique maneuvering capabilities. This will result in improved weapon line-of-fire control, expanded launch envelope, reduced weapon fire control time and increased maneuvering during weapon delivery. The anticipated benefits to future tactical aircraft include a 3 to 1 increase in air-to-air gunnery hits, an improved missile exchange ratio and a 2 to 1 improvement in air-to-surface weapon delivery accuracy is anticipated.

Over the past several years, we have demonstrated the cost and performance advantages of using nonmetallic composite materials in helicopter rotor blades. Now the Army has initiated the Advanced Composite Airframe Program (ACAP) to demonstrate that composite materials technology can be applied to primary rotor craft structures to gain significant system improvements including reduced maintenance, improved survivability, reduced weight and cost, increased ballistic damage tolerance, reduced radar cross-section, improved crash worthiness and easier repair of battle damage. The near term goals of this program are to demonstrate a 22 percent reduction in cost and a 24 percent reduction in system weight compared to a baseline metal airframe. The preliminary design phase of ACAP has been completed and the first flight is scheduled for early FY 1985.

G. Aircraft Propulsion Technology

Our technology base program in aircraft propulsion technology is guided by two important facts: (1) rather modest increases in aircraft propulsion system performance have high payoffs in terms of the range/speed/payload/size/cost characteristics of air vehicles, and (2) the time required for aircraft propulsion system development is historically much longer than the time required for airframe development. Accordingly, our goals are, in priority order: to improve performance; reduce development risk and costs; reduce maintenance costs; and reduce acquisition costs of aircraft propulsion systems. To achieve these goals we maintain: (1) an aggressive exploratory development (6.2) program, supplemented by contractor IR&D efforts, to develop advanced components; and (2) a significant advanced technology demonstration (6.3A) program in which total propulsion system improvements can be demonstrated, development risks reduced, and our knowledge of component behavior in a system environment can be increased.

This approach has proven to be productive, as illustrated not only by the significant improvements made in aircraft propulsion systems over the last twenty years but also by more recent accomplishments as well. For example, we have recently demonstrated a 20% reduction in specific fuel consumption, a 25% to 35% increase in specific horsepower, and a 50% reduction in vulnerable areas in two competitive 800-hp turboshaft engine demonstrators for helicopter applications. These configurations have also demonstrated sufficient durability such that full-scale development can be undertaken with confidence. Another recent demonstration has been a 15% increase in thrust/weight ratio, a 15% reduction in fuel consumption, and a 24% reduction in the number of parts in a large fighter engine technology demonstrator.

In FY 83 we plan to initiate a turboshaft engine technology demonstrator in the 5000 hp class with the objective of reducing the specific fuel consumption by approximately 30%. We also expect that performance improvements similar to those cited above will be demonstrated in at least one other competitive large fighter engine technology demonstrator, and that the necessary durability will be demonstrated in two of these configurations.

H. Materials and Structures

In the past our Materials and Structures Program has emphasized cost reduction and performance improvement. In FY 1983, with our growing dependence of foreign sources for raw materials, greater emphasis will be placed on substitution and conservation. This effort is aligned with the Administration's policy of recognizing materials R&D as a viable option toward alleviating possible strategic and critical materials availability problems. Emphasis will be placed on technologies to achieve more independence in the area of strategic materials including metal-matrix composites (MMCs) and rapid solidification technology (RST). These basic starting materials are predominantly obtainable from domestic or secure Free World sources.

The coordinated Navy and Air Force program in erosion resistant carbon/carbon (C/C) composite materials, directed toward improving the survivability and accuracy of advanced reentry vehicles under adverse atmospheric conditions caused increase in erosion resistance and is proceeding towards even greater reentry vehicle accuracy options. Equally important, the focused funding and technological efforts have provided the impetus to rapidly transfer and apply C/C technology to rocket motor applications. C/C composite technology has emerged as the selected nozzle design for all stages of the Air Force MX missile, the Space Shuttle Inertial Upper Stage and possibly for the advanced Trident missile system.

The technological base that the DoD has built in the area of C/C composites is being further exploited by the gas turbine community. The viability of these composite materials for application to the hot sections of gas turbines is being investigated by the Navy and Air Force. In addition to the performance gains that can be accrued because of the high temperature capabilities of C/C composites, their domestic availability and potential low cost make them attractive alternates to the high cost gas turbine superalloys. These superalloys contain appreciable amounts of cobalt and chromium, for which the U.S. is almost totally dependent on imports, hence the successful development of C/C for this application would contribute towards relieving U.S. dependency on foreign sources.

The tri-Service/DARPA thrust program for the development and application of metal-matrix composite (MMC) materials for a variety of military applications is proceeding as planned. A number of contractural and in-house efforts have been initiated in the areas of:

- o Helicopter transmission housings and portable bridging components (Army)
- o Structures for strategic missiles, mines and torpedoes, and tactical missiles (Navy)

- Airframe and gas turbine components (Air Force)
- Satellite components (DARPA)

In addition to these applications, MMC materials appear to show promise for an ever widening range of applications such as laser mirrors, lightweight gun mounts, submarine propellers, antennae, and others. One of the early results emerging from this program is the development of reinforced lead grid materials for submarine batteries. If this development proceeds successful, it can result in lengthening the submarine battery replacement cycle by a factor of two, thereby aligning it with the nuclear core replacement schedule and reducing maintenance costs appreciably.

Another significant outcome of our work in the MMC program is the potential for substitution of MMC for critical or long leadtime materials such as chromium, cobalt, titanium, and beryllium. As an example, it has been determined that high modulus graphite fiber-reinforced magnesium alloy composites exhibit stiffness, strength and dimensional stability properties equivalent to or superior to those of beryllium at the same weight. This can result in cost savings up to 90-percent for some components now fabricated of beryllium.

Our tri-Service/DARPA RST program to produce very high quality starting materials for new families of aluminum and titanium alloys as well as superalloys is beginning to show the potential for dramatic increases in aircraft performance. As examples:

- Aluminum, molybdenum, and tungsten were alloyed into nickel to obtain a 200°F improvement in heat resistance over current jet engine superalloys. The payoff is an engine which can produce higher thrust or greater fuel efficiency than any of today's turbomachines.

- o Lithium was alloyed into aluminum to obtain a 30% increase in specific modulus of elasticity and a 100 time improvement in life under cyclic stress conditions over presently available aluminum materials. The payoff is an airframe which weighs 30% less.

- o Iron was alloyed with aluminum, titanium and boron to obtain a 20% weight reduction and a 200°F improvement in heat resistance over current ferritic stainless steels. The payoff is a chromium free stainless steel for use in critical jet engine components.

The investment we have so far made demonstrates sufficient promise and maturity of this technology to justify continuing a long term financial commitment by the DoD to accelerate the development of these new materials. This technology has, moreover, demonstrated the potential for producing superior superalloys with only minor amounts of critical or scarce materials.

I. Underseas Warfare Weaponry Technology

The Undersea Warfare Weaponry Technology program is directed toward providing new technology options for future undersea mines and torpedoes. Based on a rapidly advancing Soviet threat a major thrust has been directed toward significantly improved torpedo performance. The basic technologies involved in this thrust are:

- o Guidance and control - advance acoustic homing technology.

- o Laminar flow technology - obtain major drag reductions which will allow torpedoes to run quietly and faster with longer endurance.

- o Closed cycle propulsion - to allow torpedoes to run at high speed regardless of depth.

We have made major advances in these technical areas. The accomplishments and plans which are the most significant are:

- Lithium battery technology - a major breakthrough has occurred in the development of high drain rate lithium batteries which may make them safe for submerged vehicles. This is a leading candidate for product improvement of the advanced Lightweight Torpedo now in system development. It appears that even higher power batteries are feasible which can be used to propel the next generation heavy-weight torpedo.

- Laminar flow technology - the three areas of investigation are heated boundary layer, suction, and polymer ejection. Major drag reductions have already been demonstrated in the laboratory and plans are to conduct at sea experiments in FY 1983.

Undersea warfare weaponry is truly an emerging technology which requires significant Navy, DoD, and Congressional support. It represents a credible means to counter the increasing Soviet submarine threat.

J. Electro-Magnetic Propulsion

A new class of hyperveolcity gun system utilizing electro-magnetic energy in lieu of chemical energy as the propellant is being developed. This will provide significantly increased target engagement capabilities for all military applications, with particular application to air defense, ballistic missile defense, and anti-armor weaponry.

- A laboratory electro-magnetic rail gun launcher has been designed and fabricated at the Westinghouse R&D Center. All components have been tested and a device is being assembled for full scale testing. The gun will accelerate a .3 kg projectile to velocities of 3 km/sec.

- A revolutionary compact power source (homopolar generator) has been designed capable of storing 6.2 megajoules. Component fabrication is completed and the power source will be tested during the 3rd quarter FY 82. The generator weights 3400 lbs, is 29" in diameter and 18" deep.

- Small projectiles (a few grams) have been accelerated to approximately 10 km/sec.

In FY 83 the rail gun and homopolar generator will be married for testing. Testing with the flux-compression guns will continue with increased masses.

K. Training and Personnel System Research (TPST)

Manpower is continuing to cost the Department of Defense about half of its annual budget. Militarily, we are outnumbered by our potential adversaries. We have sought to counter this superiority with quality primarily in advanced military systems. However, we must operate and maintain these systems with available manpower whose performance accounts for much of the effectiveness of military systems.

To meet this challenge, the Defense Department invests a lot for training. On an average day in FY 1982, about 200,000 active duty personnel and some 36,000 reservists will be undergoing some type of formal training. The cost of this effort will exceed $10 billion for people and $2 billion for equipment.

There is no reason to believe that these costs will diminish. The supply of eligibles will decrease over the next decade while the demand will not. For example, the airlines predict that over the next five years, more than 50 percent of their maintenance personnel will be retiring. The Air Force is looking at how they will handle the potential drain on maintenance personnel as these retirements take place.

It is the responsibility of our Training and Personnel Systems Research and Technology effort to meet the long and short term training and human factors needs. The 1981 Defense Science Board Summer Study focused on the issue of training and the readiness of our personnel. It noted that available technologies represented by microcomputers, educational aids, video discs, electronic games and the like could serve as "personal learning aids" to: (a) compress training time by up to 30 percent; (b) help our personnel obtain greater levels of skill, with more flexible training curriculum; (c) reduce the need for many instructors; and (d) provide "on the job" aids for the retention of skills. In conclusion the summer study recommended that we start priority programs on man-machine design in order to improve job performance. We are asking the Services to pay closer attention to personnel and training implications and to place increased emphasis on the use of microprocessor based learning aids and devices. In addition, we have asked the Services to survey their technology developments and needs and to advise us which projects could become tri-Service funded. In FY 1982, we have identified and are funding four such projects: (1) manpower and training research information system; (2) personnel electronic aids for maintenance; (3) computeraided testing modifications for Armed Services Vocational Aptitude Battery development; and (4) computer-based instructional systems for the classroom.

L. Medical and Life Sciences

The Medical and Life Sciences Program is directed principally at solving "people" problems which may have an adverse impact on military operations and military systems. Major goals of the program are: to prevent militarily-important disease and injury; to improve the care of the combat casualty; to maintain and enhance human combat effectiveness and performance of individuals and man-machine systems; and to enhance human safety in military systems.

The medical R&D consolidation study conducted in fiscal year 1981 at Congress' request, recommended formation of an Armed Services Biomedical Research Evaluation and Management (ASBREM) committee to coordinate and integrate Defense medical research efforts. The ASBREM is now functional and has designated several coordinating groups, each of which is concerned with a specific technical area of the program.

In response to FY 1982 guidance from Congress, we have designated the Army as lead Service for infectious disease and combat dental research and development and have directed the Army and Navy to begin to integrate their respective research programs in these areas. The Army is currently preparing a plan to insure maintenance of the Navy identity and participation in these research efforts. The Navy is to conduct research on dental disease and non-combat dental emergencies on behalf of all DoD components. Appropriate adjustments to support these decisions have been included in the FY 1983 budget.

We have also requested that the Services begin planning for program consolidation in the area of combat casualty care research, using the lead agency concept. We anticipate that the results of this latter effort will be reflected in next year's budget submission.

The DoD drug and vaccine development effort, for which the Army has been primarily responsible, has recently produced a number of preventive agents of military importance: meningitis vaccine; adenovirus vaccine; and a new anti-malaria drug mefloquine. This program will require increased support for the foreseeable future as it addresses drugs and vaccines needed for projected operations in areas of the world where disease is a major military obstacle.

A significant part of our medical R&D effort is associated with medical defense against chemical agents, a topic addressed separately.

M. Undersea Target Surveillance

The Undersea Target Surveillance Program investigates the relevance and technical feasibility of potential solutions to Navy operational needs in undersea surveillance. The primary undersea targets sought are the submarine whose torpedoes, cruise missiles or ballistic missiles threaten U.S. submarine, surface ships and territory. Targets are dealt with on a global basis which includes surveillance of large ocean areas, choke points, areas around theaters of activity and designated areas of special interest. The platforms from which surveillance is performed are land-based facilities, submarines, surface ships and airplanes. Most of the surveillance sensors under investigation are acoustic, relying on radiated acoustic noise and active acoustic (sonar) signal returns from the targets. Other sensors under consideration are optic, electromagnetic, and magnetic to complement the more mature acoustic sensors. Sensors are deployed singly or in arrays, where the geometry and spatial extent provide signal gain. All of the sensor information, acoustic and nonacoustic, is processed by computers using sophisticated data processing algorithms to detect, localize, classify, and track the target. There is an increased emphasis in the program on detection of acoustically quieter targets in noisier environments.

Land-based surveillance systems are being considered which receive and process information from fixed undersea sensors or sensor arrays via cables and from drifting undersea sensor arrays via data relays. The overall objective of this work is to exploit new technological advances in signal and data processing in order to lower detection thresholds, extend the range of parameters of the signals used for detection, reduce false alarm rates, more accurately identify and localize targets, and ease operator burden. New processor component and architecture technology is being investigated to achieve the dramatic increases in processing throughput needed to meet future surveillance requirements. Algorithms and processes are developed in laboratory settings and evaluated using both simulated and real-world recorded data sets. Inter-array processors, improved displays, data base management algorithms, optical processors and information extraction from previously neglected signals have recently been demonstrated in the program.

Expendable acoustic sensors and small aperture sensor arrays deployed in sonobuoys are the vital elements in the Navy airborne ASW systems. Passive and active sonobuoys are being consistently updated to improve capability, reduce cost and counter threat advances. Airborne magnetic and optical detection systems are also being investigated to complement the acoustical systems. The detection and frequency range of passive sonobuoys is being extended and the performance of a high gain extended life deployed horizontal line array is being investigated. Methods are being developed to improve the capability of airborne active sonobuoy systems by reducing reverberation and optimizing design parameters against the future threat. Substantial progress has been made in developing these nonacoustic sensors and they will be flight tested in varying environments to define their operational performance potential.

N. Electronic Warfare

The electronic warfare (EW) technology program covers a broad spectrum of activities in the functional areas of detection, warning and location, jamming and deception, signal reduction and obscuration, counter-countermeasures, and exploitation and simulation. The technology base investment in EW totals $122 million in FY 1983, with about 50% of the effort concentrated on jamming and deception. This is primarily due to the deficiencies in our current capability in jamming and deception and the potential utility of this technology as a force multiplier if properly conceived and implemented. The counter-countermeasures area is experiencing real growth in response to the magnitude and sophistication of the projected threat.

The technology thrusts in the area of detection and location include improved receivers to operate at higher frequencies with larger bandwidths utilizing advanced signal processing for analyzing and matching signals. The jamming and deception initiatives include software programmable jammers operating at higher frequencies with lower cost, reduced size, threat sorting and prioritization capability. The signal reduction area includes visibility reduction of aircraft, improved smoke, obscurants and chaff. The counter-countermeasure areas include low probability of intercept, spread spectrum, frequency diversity, adaptive antenna nulling and signal analysis and processing. The exploitation and simulation areas include the analyses of vulnerability of hostile systems to countermeasures equipment and techniques.

Recent accomplishments in the warning area of the electronic warfare program include the following:

- o Acousto-optic (AO) technology is being utilized to achieve significant improvements in electronic warfare support measures (ESM) passive detection. The AO technology provides the capability for instantaneous channeling of received signals in both frequency and direction of arrival with wide bandwidth and high resolution. Such threat warning is essential in a dense signal environment, to allow ECM procedures to be activated. Cost reduction is expected by the use of monolithic integrated optics.

- o Development of a laser warning receiver to provide the pilot of an aircraft with sufficient warning of an impending laser threat for evasive action or countermeasures. The laser warning receiver is designed to interface with existing microwave radar warning receivers.

- o A dual mode warning system for detection of surface-to-air IR guided missiles, capable of operating in a high false alarm rate environment. The system provides redundancy through the independent use of either sensor in case of a failure.

The proliferation and increased effectiveness of hostile electro-optic (EO) based weapon systems such as optical trackers, night vision equipment and EO augmented weapons has caused an increase in emphasis on EO technology. In particular, there has been a rapid growth in countermeasures (CM) to EO weapon systems. Other trends include multispectral warning systems utilizing ultra-violet, infrared and lasers, and increased emphasis on low observables as a countermeasure to both RF and EO weapon systems. The limiting factors to EO countermeasures include: (1) the lack of intelligence information on specific characteristics of known threats; (2) costs, performance and reliability issues which depend on the size and complexity of the CM systems; (3) tracking and stabilization requirements, target locations and handoff methods; and (4) the potential employment of counter-CM techniques.

There are a number of technological challenges with significant impact on electronic warfare in the 1980's. Current EW jammer capability is penalized in many cases by the limitations of power amplifiers. We need high power microwave amplifiers, more efficient tubes with greater bandwidths, broadband high power lasers and millimeter components, broadband phased arrays utilizing these components and adaptive optical decoys. We will continue to work on these challenges.

O. Adverse Weather Precision Guided Munitions

To offset the large numbers of Warsaw Pact weapons facing NATO forces, a major DoD thrust has been identified in precision guided munitions (PGMs). The objective of this PGM thrust is to develop a force multiplier effect by reducing vulnerability of the PGM launcher and crew, increasing kill probability per engagement, extending the range of target engagements, and providing a multiple kill probability by delivering a large number or terminally guided submunitions into the target area via a single delivery vehicle. In the past three years the PGM thrust was further expanded to develop a capability to engage targets in a realistic battlefield environment which includes adverse weather conditions.

This adverse weather PGM thrust requires significant technology advances in the following:

- o Launcher technology - develop a means to separate the launcher and the crew so that the crew location is not compromised when a PGM is fired.
- o Mid-course guidance technology - provide more cost effective and highly accurate delivery of PGMs at longer ranges through development of lower cost inertial components and utilization of correlation update techniques.
- o Terminal guidance technology - develop an autonomous terminal homing capability utilizing advanced signal processing techniques at frequencies that have good transmission properties in battlefield aerosols, dust, fog, rain and snow.

Recent technology accomplishments have shown the PGM thrust to be a feasible goal.

- o We have been able to develop advanced signal processing algorithms which enable a terminal homing seeker to select the target of interest in a cluttered background environment and home on that target.
- o A highly accurate inertial guidance system using the ring laser gyro has been developed and demonstrated, which provides good mid-course guidance capability at a fraction of the costs previously projected.
- o The DARPA/Army Assault Breaker Program has demonstrated a capability to deliver and dispense a large number of terminally guided submunitions into an armored target formation using a single delivery vehicle.

Some FY 1983 plans to demonstrate new technology supporting the PGM thrusts are:

- The Air Force/Navy adverse weather seeker program will demonstrate both synthetic aperture radar and millimeter wave seekers against a high value target spectrum including major naval combatants, bridge, railheads, etc. This program is the first DoD attempt to identify, classify and attack targets other than armor.

- The Air Force/Army infrared seeker demonstration program will utilize advanced focal plane array and signal processing technology to advance the state-of-the-art of imaging infrared terminal homing to increase the hit-to-kill probability of anti-armor munitions.

- The Air Force mid-course guidance demonstration program will demonstrate a modular missile utilizing digital information distributed throughout the missile airframe.

IV SUPPORTING PROGRAMS

A. Global Weather Support

Weather support (meteorological, oceanographic, etc.), properly structured can be a powerful force multiplier, i.e. a technology which can substantially multiply the effectiveness of our forces. It is a key ingredient to all phases of the life cycle of a weapons system. Proper consideration in the concept and development phases includes designing around adverse weather effects or developing techniques for mitigation of unfavorable weather. Weather must be adequately considered during the critical test and evaluation stage to properly validate system performance in realistic military situations. Weather support is critical in planning to ensure realistic expectations of performance. Finally, the battlefield commander requires timely, accurate weather support to employ his forces economically and effectively.

We have made considerable progress in understanding the effects of the natural and man-made obscurants upon our infrared and optically guided weapons, but much still needs to be done. At the present time we are conducting a major joint Service field experiment which is establishing the technology base for understanding the effects of snow on these modern weapons. We have already established that falling snow can have a major impact on the employment of the laser, infrared and EO systems and we are now defining the significant elements needed for the critical weapon selection decision to be made by the battlefield commander. History shows us that winter has served as an effective ally of Russia in every major war in which they have been involved in the last 300 years and we are now working to understand winter conditions better and to take advantage of them.

A major focus of our weather program is on the techniques and equipment needed to convert normal weather data into direct tactical and strategic weapon system parameters and to deliver that information directly to the battlefield commander. All Services have major programs directed toward this important goal. Following the recently implemented shipboard refractive index prediction technique to provide key radar defense data, the Navy will be testing several new operational techniques to provide the ship commander with tailored weather information for the use of electro-optical weapon systems in shipboard defense. The shipboard Tactical Environmental Support System will tie together all the data sources and techniques to provide the ship commander with the complete picture needed for his tactical offensive and defensive operations. The Air Force is developing the critical techniques and equipment needed to obtain crucial weather information direct from behind the enemy lines for immediate receipt and direct application by the battlefield commander. The Air Force is also developing an Automated Weather Distribution System to modernize our 1950's weather station technology to provide rapid and accurate distribution of weather information to users both in the CONUS and overseas. The Army is in the final engineering development of the meteorological sounding system to replace the 1949 era equipment currently used to provide the critical cross-wind data in support of our field artillery.

The equipment for supporting our CONUS bases has much in common with that required to support the weather facilities of the National Oceanic and Atmospheric Administration (NOAA) and the Federal Aviation Administration (FAA). We are currently participating in a Joint Systems Program Office for the development and acquisition of a new, advanced Doppler weather radar system, the Next

Generation Weather Radar, which will replace the aging weather radars of all three organizations. This common radar will permit significant economies in training and logistics in addition to providing a significant and immediate enhancement to our ability to detect, track, and predict the severe storms which threaten our high value resources. We are also exploring a similar joint arrangement for the development and acquisition of automated observing systems which could have significant implications for future manpower and basing structures.

In summary, we are committed to a vigo ous weather support structure within DoD which takes full advantage of the civil programs and which is responsive to the entire spectrum of needs -- from that of the system designer through that of the battle area commander, on land or at sea.

B. Independent Research and Development (IR&D)

Independent Research and Development (IR&D) is a term devised to differentiate between a contractor's research and development technical effort performed under a contract or other agreement, and that which is independently conceived by a company to maintain its technological position. The IR&D designation includes the full spectrum of effort from research through product development and also encompasses system and concept formulation efforts. In simple terms, IR&D is a method of teaming DoD with the American industrial sector to promote research and development of value to national defense.

The Defense IR&D program continues to be a major contributor to our technological strength by bringing the innovative capacity of U.S. industry to bear on defense problems at relatively low cost. The IR&D effort is structured by the companies themselves to advance their technologies in ways they feel will enhance their competitiveness and efficiency in developing high-technology products.

By supporting the IR&D effort of industry, through the reimbursement of about one-third of contractors' total IR&D expenses, DoD realizes the use of of industry's IR&D. The net effect, of course, is that the amount of R&D performed which is of available to DoD is considerably greater than that which DoD obtains solely through its technology base appropriations.

D. International S&T Cooperation

Consistent with our objective of cooperating with our Allies, we are continuing our close S&T international relationship through two major programs. These are the NATO Defense Research Group (DRG) and The Technical Cooperation Program (TTCP). I am the U.S. Principal on these programs, and it is my intention to develop initiatives within the participating countries which promote strong S&T information exchanges and collaborative endeavors leading to a stronger and more viable technology base for the Alliance as a whole.

V. CONCLUDING REMARKS

The total FY 1983 budget request including both the Services and Defense Agencies, is $4.3 billion. I consider it important that we maintain superior science and technology to serve as a source of our future systems and as a hedge against adverse technological surprise. I am confident that the funding requested in FY 1983 will be adequate to ensure achievement of our objective of maintaining a level of technological supremacy needed by the country to develop and maintain the military capabilities required for national security. We will be able to maintain a healthy and vigorous technology infrastructure which will enable us to continue steady evolutionary growth in military technology, to recognize and exploit revolutionary technical advances and to evaluate Soviet progress and advances in a rational and realistic fashion.

The growth will be directed among the Government, university and industrial laboratories. This combination of talent is still without parallel in the world, and adequate funding is essential in order for the U.S. to exploit its most important asset in the age of high technology military forces.